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Technology Information

Immobilization of heavy metals by oversaturated $Ca(OH)_2$-grouts

Fundamentals

Lime addition is widely used to treat acidic soils as well as waste waters. The resulting pH increase leads to the precipitation of metal hydroxides. Due to the low solubility of $Ca(OH)_2$ (at 25 °C approx. 1.8 g/l) solid lime or suspensions are used.

Comprehensive laboratory investigations have shown that the solubility of $Ca(OH)_2$ increases in the presence of special, non-toxic complex forming agents. These offer the possibility to prepare clear solutions with concentrations high above the natural solubility of $Ca(OH)_2$. There are two ways to obtain such solutions:

- Dissolution of $Ca(OH)_2$ in a solution containing the complex forming agent (Fig. 1),
- Mixing of NaOH or KOH solutions with $CaCl_2$ solutions in the presence of complex forming agents (Fig. 2).

The first method requires higher amounts of complex forming agents and leads to solutions containing up to 30 g/l dissolved $Ca(OH)_2$. The second way results in solutions with $Ca(OH)_2$ concentrations up to 25 g/l.

The chemical behavior of the solutions is similar to pure $Ca(OH)_2$ suspensions. Mixing with acidic solutions results in the precipitation of metal hydroxides. The amounts of precipitated metals depend on the solubility product of the metal hydroxides and the mixing ratio with the grout. Immobilization is achieved both by precipitation of diluted metal ions and by the formation of hydroxide layers on reactive mineral surfaces.

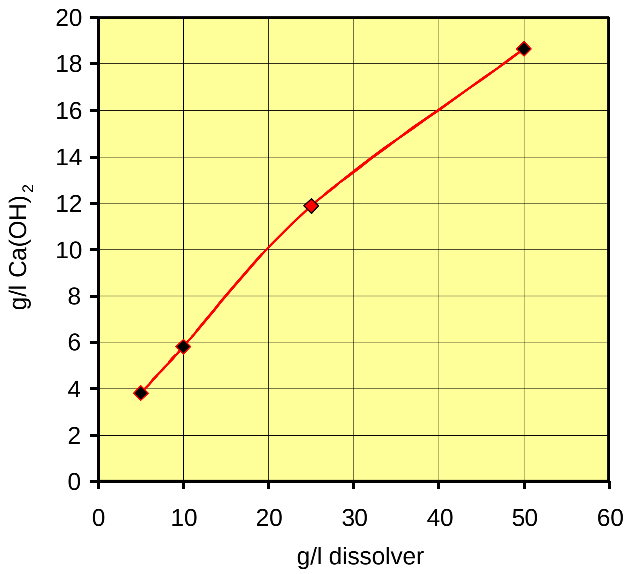

Fig. 1:
$Ca(OH)_2$ solubility depending on the concentration of the complex forming agent

Applications

$Ca(OH)_2$ oversaturated solutions have a stability between 24 and 72 hours, depending on the absolute concentration and the amount of dissolver. After that time, $Ca(OH)_2$ precipitation starts. If soil formations are penetrated with $Ca(OH)_2$ solutions in-situ precipitation of calcium

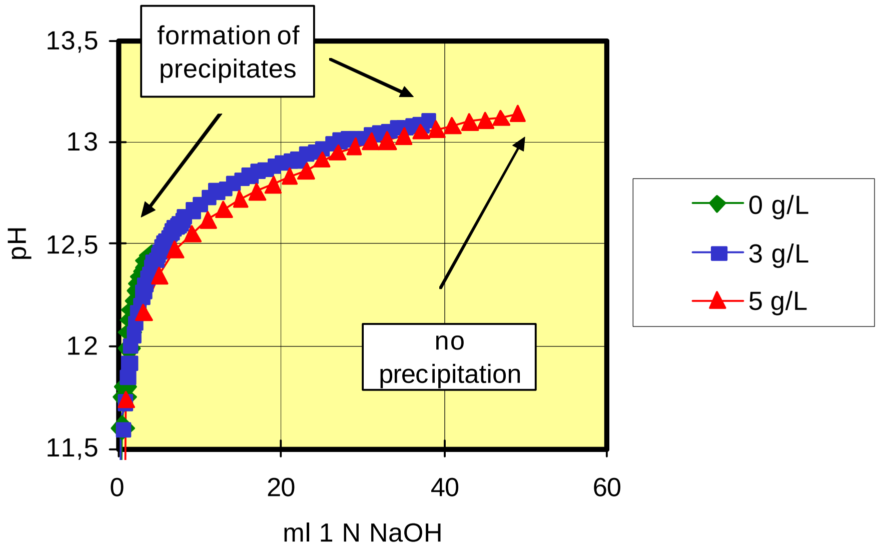

Fig. 2: Mixing of 100 ml $CaCl_2$ solution (11 g/l) and 1 M NaOH in the presence of different dissolver concentrations

hydroxide takes place. $Ca(OH)_2$ covers the mineral surfaces and acts as reactive barrier. In contact with air, $CaCO_3$ is formed. The present organic components generate reducing condition. A strong increase of the acid neutralization capacity is achieved. For practical applications, solutions containing between 3 and 10 g/l dissolved $Ca(OH)_2$ are favorable. To increase the ability to immobilize heavy metals it is possible to add further compounds such as sodium sulfide.

Fig. 3 shows the results of column tests. In a first step, the sand filled column was saturated with pure $Ca(OH)_2$ solution (12 g/L) in a first step. 72 hours later, a solution containing 1 g/l $FeCl_3$ and 1.33 g/l Na_2SO_4 was pumped continuously through the column. After 25 hours the Cl^--concentrations indicate constant flow conditions. The pH value lies at 12. Iron could not be detected in the output solution. Only after 80 hours the pH of the output solution decreased to 7. Within this time the pore volume of the column was replaced more than 6 times by the $FeCl_3$/ Na_2SO_4 -solution.

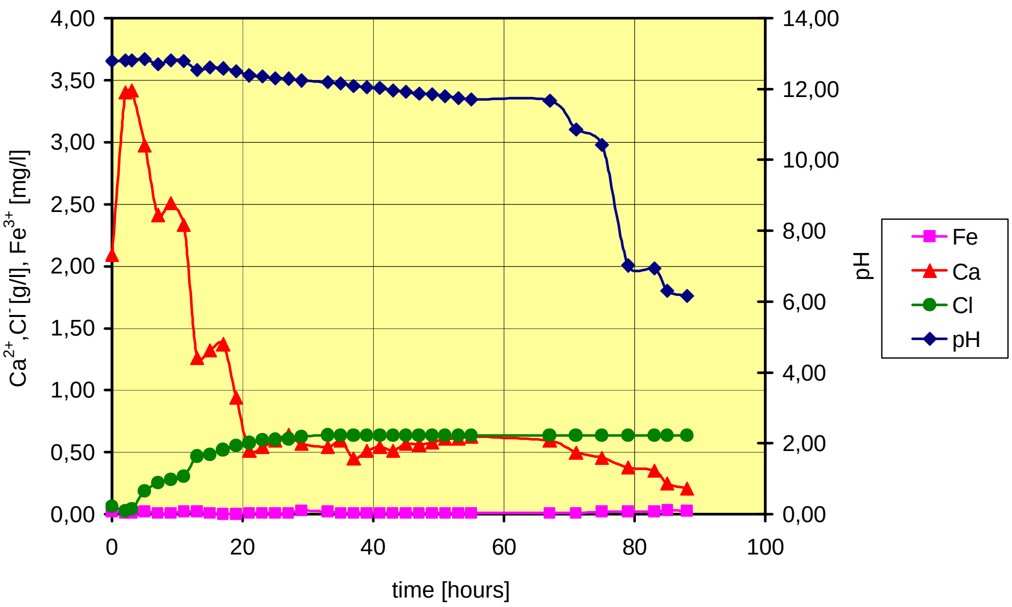

Fig. 3: Results of column tests